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United States Department of Agriculture

OFFICE OF EXPERIMENT STATIONS.

CIRCULAR NO. 19.

**Experiments with fertilizers on fruits and vegetables, to study
the feeding capacities of the plants and the variations
due to the action of fertilizers.**

WASHINGTON, D. C., MARCH, 1891.

DEAR SIR :

It is becoming evident that the kind of experimental study which has given us our present knowledge of the ways in which our field crops are affected by fertilizers, needs to be applied in the study of garden vegetables, small fruits, and orchard fruits. This is one of the most useful lines of horticultural experimenting which our stations can follow. The value of the work and the quickness with which results can be obtained will be in proportion to the character and extent of the co-operation among station horticulturists. It is clear that for the best success it will be necessary to select narrow and specific questions, make definite plans, carry out the experiments accurately and thoroughly, unite in the work so that a large number of comparable data may be accumulated, and prosecute the inquiry until clear and decisive results are obtained. To this end the following questions and plans for experiments are proposed :

Questions.—The purpose of the experiments for which plans are here outlined is to study the effects of different fertilizers upon horticultural plants. More specifically, the object is to get light upon (1) the feeding capacities of the different plants, and (2) the variations in character of the product due to the action of the fertilizers. The relations of the plants to nitrogen, phosphoric acid, and potash are to be especially studied.

Kinds of plants.—Eventually experiments will doubtless need to be made with all ordinary cultivated plants, but for the present it seems

desirable to confine our attention to such as are easily grown; are cultivated on soils of different kinds and over wide areas; represent widely different kinds of products, as roots, leaves, fruits and seeds; and are somewhat compact in their growth, so that the space occupied by roots and tops should be approximately the same, thus excluding for the present, melons, squashes, and the like. Probably the kinds which may now be most advantageously experimented with in most localities are such as the following:

(1) Garden vegetables. — Tomatoes, beans, peas, beets, radishes, spinach, and cabbages.

(2) Small fruits. — Strawberries, raspberries, currants, gooseberries, and particularly grapes.

(3) Orchard fruits. — Such as the circumstances in each case may suggest, but especially apples, peaches, pears, plums, and cherries.

Kinds of fertilizers. — For fertilizing materials, it is desirable to use those which furnish nitrogen, phosphoric acid, and potash, in convenient commercial forms. Other materials, as ashes, lime, and farm manures, may also be used to advantage as circumstances indicate.

General plans for experiments. — For the present, field, garden and orchard trials will doubtless be most feasible. The general method of experimenting may advantageously be that which has been in use for some time at experiment stations and elsewhere, and is described in Circular No. 7 of the Office of Experiment Stations, on Co-operative Field Experiments with Fertilizers, a copy of which is here enclosed.

A simple form of experiment is that described on page 17 of that circular, in which nitrate of soda, dissolved bone-black, and muriate of potash are to be used singly, two by two, and all three together, other materials being used at discretion as suggested on page 30. These comparatively easy and inexpensive experiments will serve to bring out the special effects of the several fertilizing ingredients upon the different plants under the different circumstances of soil and treatment, and if a considerable number are made on the same plan, data will be accumulated for generalizations of value.

It is, however, desirable to give special attention to the feeding capacities of the different plants, that is to say, to the ways in which each is affected by particular elements, and, inferentially, its power to supply itself with food from natural sources. We know that such cereals as wheat and oats respond especially to nitrogen while the legumes are but little affected by the nitrogen, but are strongly influenced by the mineral fertilizers. There seem to be indications that for certain orchard fruits, as apples and peaches, potash is a predominant ingredient, and it may be found that in the very important matter of growing nursery stock, nitrogen is a controlling factor. What we want to find out is the facts. For large areas of the country where horticulture is already an important industry

and rapidly becoming more so, service of incalculable value can be rendered in this direction.

On pages 26–28 are suggestions for special nitrogen experiments. Although these, like those on page 17, were devised for field crops they are equally applicable to vegetables and fruits. It will be observed in the schedule on page 27 that the fertilizers Nos. 1 to 7 are identical with those of the simpler experiments of page 17, and that nitrogen is supplied in different forms and amounts along with phosphate and potash salt in the three nitrogen groups of Nos. 7 to 15. If an experiment on this schedule is too complicated either Nos. 1 to 5 of the preliminary group, or one or two of the nitrogen groups can be omitted.

On page 34 are suggestions for special phosphoric acid and potash experiments on the plan of those for the special nitrogen experiments. It is especially desirable that the effects of potash be tested upon fruiting plants, both small and orchard fruits.

Arrangement of plats. — Sources of error. — Duplication of plats.—The statements of pages 36–38 regarding arrangement of plats and sources of error apply to experiments with horticultural crops. Doubtless here, as in ordinary field experiments, one chief source of difficulty will be found in the unevenness of soils, which is due to differences in mechanical and physical characters; to variations in moisture supply as affected by location, slope, character of soil and subsoil, drainage, etc.; and to the varying effects of the supplies of plant food left in the soil from previous manuring or plant growth. Generally speaking, these sources of error will be best avoided by careful selection of the land and by duplicating the plats, both manured and unmanured. The duplication of plats, both manured and unmanured, is especially desirable. With vegetables and ordinary small fruits the small-plat system, as used for field crops, may properly be used. In orchards, it will be well to arrange the plats so as to leave one row unmanured between each two manured plats.

Results as indicating both the feeding capacities of the plant and the effects of fertilizers upon the character of the product.—While these experiments are planned to study the relations of the different plants to the valuable fertilizing ingredients, they will also be useful in observing the specific effects of the fertilizers upon the size, appearance, flavor, and other characters of the products, which is a matter of no less economic and scientific importance. Illustrations will at once occur to every horticulturist, such, for instance, as the fact that the fertilizer often makes such a difference in the character of a plant that the propagator regards it as a new variety and announces it as such.

General suggestions.—With orchards it seems desirable to work only in those which are cultivated, in order that the fertilizers may be more easily and effectively applied and their action upon the fruit may be

made more apparent than would be the case if grasses or other plants were growing on the same ground. Fruit-trees, more than annual plants, have peculiarities and disabilities due to conditions of soil, growth, care or neglect, injuries by fungi and insects, etc., which require special adaptation of plans to individual cases. In other words, it is more difficult to adhere to a definite schedule for fertilizer experiments in an orchard than with garden and field crops, and the judgment of the experimenter must be relied upon to adjust plans to the conditions under which he works. Inasmuch as the stations do not have land representing all the varieties of soils in their States, or orchards in condition for experiment, it will in many cases be desirable to secure the co-operation of intelligent fruit growers and truckmen, but the stations ought to know the men and personally supervise the work.

Of course each experimenter will have to select crops and soils best suited to his conditions. The great point is to work on a given plan and have the plan such as experience approves. Then by careful work, frequent consultation, and proper compilation of results we may hope for success.

Will you not be able to join? We can accumulate some experience this season, share it with our fellow workers, use the teachings for better experiments in the future, and thus by systematic co-operation secure results of the highest value.

Respectfully,

W. O. ATWATER,
Director.

Approved :

EDWIN WILLITS,
Assistant Secretary,